Mantle Origin of Oceanic Carbonatites

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Introduction

Carbonatites have generally been associated with rift systems, such as the East African rift which holds the world's only active carbonatite volcano Oldoinyo Lengai. There are occurrences of carbonatite on every continent, but there are only two islands in the world that contain carbonatites. Fuerteventura in the Canary Island chain and the Cape Verde islands off the west coast of Africa both contain calciocarbonatites and are associated with alkaline silicate rocks. These rocks contain many rare earth elements, making them very economically important, as well as giving us a glimpse of a rare phenomenon in the earth.

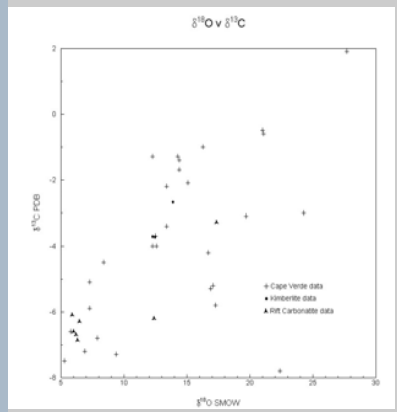
Research Objectives

The goal of this research was to determine the mantle origin of oceanic carbonatites through the analysis of stable and radiogenic isotopes. This was also compared to rift carbonatites and kimberlites to see if there is a correlation in the isotope configurations pointing to a similar mantle origin.

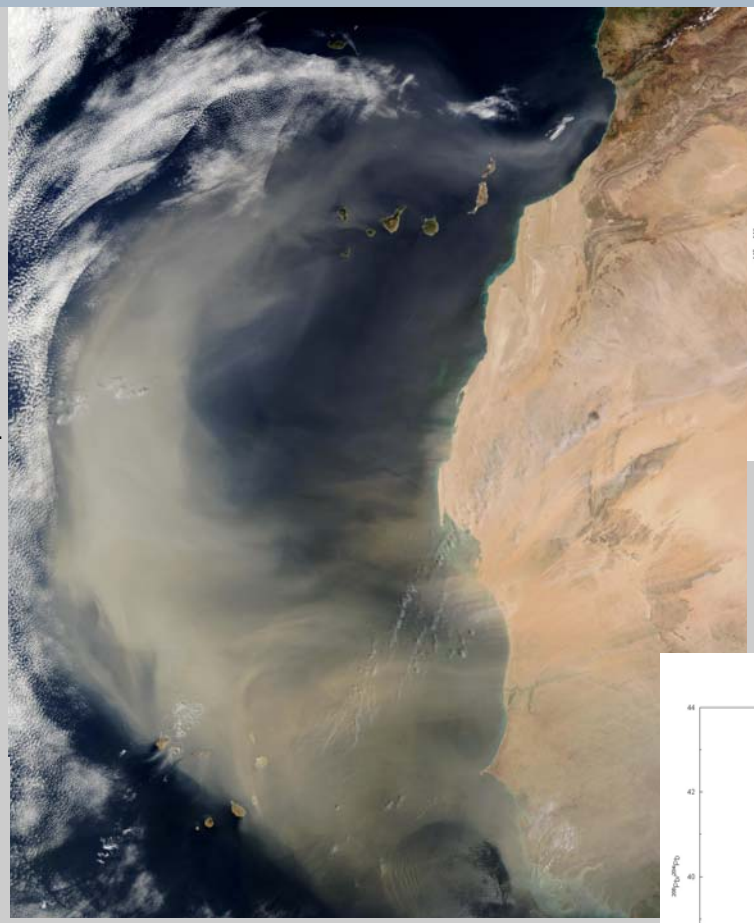
Analytical Methods

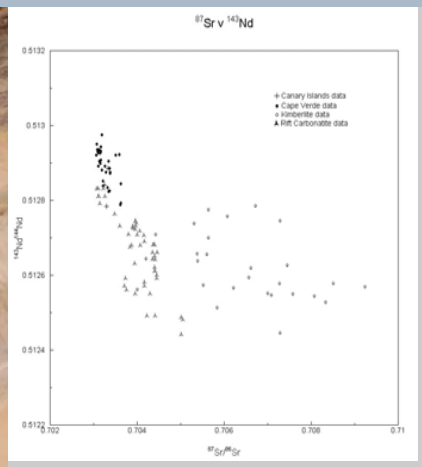
Chemical data including major oxides, isotope and rare earth element data from Fuerteventura, Canary Islands and the Cape Verde Island chain were obtained from the GeoRoc database. This database was also used to obtain data from the young carbonatites in the East African Rift system, particularly the Oldoinyo Lengai volcano and kimberlite data from around the world. The program cohort6 was used to make graphs of the data for easy interpretation.

Results

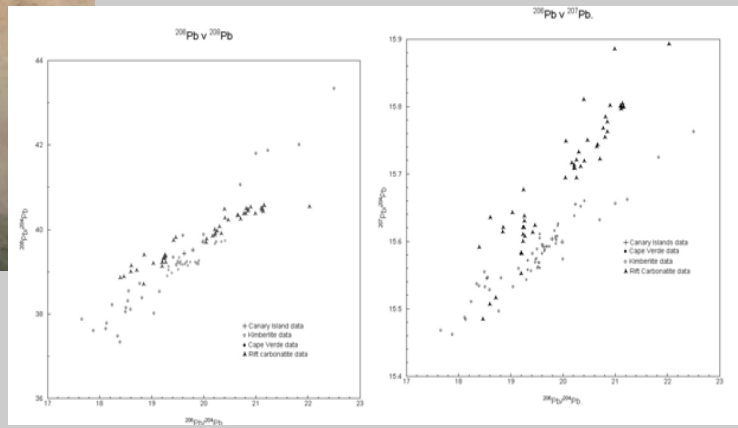


The stable isotope data for Cape Verde shows that it is depleted in ^{13}C and enriched in ^{18}O relative to the standardized values. There is a wide span to the data, but it correlates with the data for kimberlites and rift carbonatites. This wide variation in ^{18}O composition suggests some contamination by marine water or some other mechanism. This could also be accounted for by interaction between carbonatites and their associated silicate rocks, in this case ijolites and nepheline syenites.





The $^{143}Nd/^{144}Nd$ vs $^{87}Sr/^{86}Sr$ ratios show that the oceanic carbonatites in particular have a very restricted profile, suggesting that there is a close genetic relationship between the two. The rift carbonatites and kimberlites, on the other hand show much more varied isotopic compositions, the kimberlites generally being more enriched in ^{87}Sr and the rift carbonatites being depleted in ^{143}Nd. The oceanic data is in agreement with de Ignacio et al., placing this data near the HIMU component of the mantle. This points to a recycled oceanic origin. This depleted Sr component also shows a connection with the FOZO component of the mantle.



The lead isotope data agrees with the Sr data in showing the HIMU, Pb enriched mantle component. They also plot along normal values for OIB.

Citations

Image Courtesy of visibleearth.nasa.gov

GeoRoc database, under the supervision of the Max Planck Institute http://georoc.mpch-mainz.gwdg.de/georoc/

de Ignacio, Cristina, . "Isotope geochemistry and FOZO mantle component of the alkaline-carbonatitic association of Fuerteventura, Canary Islands, Spain.." *Chemical Geology*. 232 (2006): 99-113. Print.

Future Work

The next step that needs to happen in this research is to flesh out the stable isotope data that exists for carbonatites, especially for Fuerteventura in the Canary Islands. There also needs to be more stable isotope data from kimberlites in order to compare them to carbonatites to tell the difference in mantle origin. In the limited time allotted, focus stayed on isotopic data to determine the origins of carbonatites, but trace element and rare earth element data could also be used for the same purpose.